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Table of Contents:

Introduction

The purpose of the study is to examine the issue of target detection, multiple target tracking and threat identification from ICBMs and their warheads. The study is to propose how to perform sensor fusion and data fusion in a biological equivalent system using fuzzy neural networks. Matlab is to be considered, as it is a rapid development tool.

Summary:

The biological equivalent system identified is the compound eye of the housefly. Entomologists believe that the compound eyes are adapted to seeing swiftly moving objects. The housefly lacks a cortex so the system performs object recognition and tracking without high level computation. The housefly performs sensor fusion that is highly noise tolerant and the fly reacts to movements of less than 2/10 of a degree even though the calculated angle for each lens of the compound eye would be for two degrees of movement. By mimicking the housefly using several infrared detectors in an overlapping manner, the ability to tolerate noise and detect targets is increased and the angle of resolution should be improved by ten times.

The fuzzy neural network has the ability to track an unlimited number of multiple targets. Tracking is accurate even when the targets have a very complex movement and there is crossover in motion. The combination of a fuzzy neural network, which is also highly tolerant to noise, with the housefly's sensor fusion, should yield a system that is very precise. The system should perform multi-pixel object recognition in addition to single pixel tracking. The fusion of many radar sensors into the system will produce a radar system that is highly noise tolerant and adds the radar's abilities of ranging, Doppler and chaff penetration. Radar enhances the system's target identification and tracking ability. Data fusion of remote sensor is inherent to the system.

Conclusion:

The fuzzy neural network system based on the housefly's compound eyes visual system promises a fast and highly accurate system for target detection, multiple target tracking and threat identification from ICBMs and their warheads. Sensor fusion and data fusion are inherent to the system and give the high performance of the system.

Section II: Method to arrive to Conclusion:

The conclusion is based on information gained from written material from newspapers, technical journals, technical papers and books. Following this section are the references. The knowledge gained from the references to arrive to the conclusion is summarized below.

To identify, track and intercept an ICBM the characteristics and methods of sensing the ICBM need to be known. The launch of an ICBM has a large and bright rocket plume. The plume can be detected by the characteristic of infrared absorption due to the H_2O and CO_2 in the plume. The plume also has metal particles and the Doppler of the plume is in the opposite direction of the ICBM. The body of the ICBM has a high temperature from air friction. At the height of the trajectory the ICBM's warhead will separate form the ICBM's body. The warhead is much smaller and is surrounded by chaff and decoys. There is also jamming radar. The decoys can be distinguished from the true warheads as the decoys lack the mass of the warheads. There are methods for dealing with chaff and jammers.

The warhead must be detected quickly and intercepted prior to the warhead reentering the upper atmosphere. NORAD may have 15 minute warning of a launch and an interceptor may only have 100 seconds of flight time. The actual time for making the decision that the launch is a threat is after the payload separates and takes an angle and velocity to come down on the US.

For most of the time the target appears as a single infrared pixel. The combination of Doppler with single pixel can fix the target's coordinates. Time of the coordinate must also be accounted for. The time of the reception of the data and correcting for time delay from receiver electronics and propagation delay of the wave from the target to the receiver must be done.

The difference of radar from infrared is that search radar can quickly find an object and find its range and tracking radar is good at following the target. Radar has a large angle that the target may be in. Infrared can track a target to a smaller angle but can not measure the target range.

To quickly detect and track multiple targets, all the available radar, infrared and laser data needs to be organized and processed in as few steps as possible. A biological comparison is the housefly's compound eye with 4000 individual hexagon shaped image-forming elements. Also, the fly does not have a cortex so there does not exist a high computation of vision. The fly is able to organize and process data in a simple system. Each hexagon element has a directional view of two degrees in its vision. The output of the hexagon element is to eight receptors. The receptors do not receive the same view of space from the eight hexagon elements, but an overlapping offset from the elements. Another issue is that the input is adjusted for intensity. This setup allows the fly to react to movements of less than 2/10 of a degree. Entomologists believe that the compound eyes are adapted to seeing swiftly moving objects.

The fly's model implies that the issue of different location of radar, infrared and laser sensors can be dealt with by organizing the sensors with overlapping field of view. The result is a system tolerant to noise and the detection ability of locating the object to an angle is more accurate.

As a general-purpose detection and tracking computer, not all resources of radar and infrared may be available in a search area. The "Artificial Neural Network Analysis System" must be able to use what is available and produce an accurate detect or tracking. This ability to adjust for the unavailability of a sensor has the added benefit if the unavailability was due to malfunction or lost by military action. To account for the difference in sensor input timing difference, the last input needs to be held and given a life, the data can expire at the end of its life. When there is not an input the life is zero.

The fly's eye does take information from separate lens as single pixel detection and fuses the single detection with other single detection from other lenses. This has a natural offset and overlap. Due to the ICBM's great distance from sensors, the fusion of separate sensors can mimic the process of the fly's system. When one sensor is off to the side of the ICBM the model has a dramatic change. This can be compared to an object that is close and between the eyes of the fly. Another ability of the fly is to go from single pixel movement detection to feature recognition when the image becomes a multi-pixel image without having to include additional steps. In the same subclass as the housefly is the dragonfly. The dragonfly is territorial and hunts flies as prey. The dragonfly performs detection, tracking and interception as a hunter. However the study [4] is on houseflies. The ability to identify, track, and avoid obstacles needs an ability for short term memory and an instinct (memory recall) to recognize objects. The fly's organization of data is forced by the precise construction of its compound eyes and the connection from the eyes to the neural system. To mimic the fly's system by various sensors at different locations require a communication system. The sensor data needs to be organized for input into the "Artificial Neural Network Analysis System". Having a fixed system with sensors gives the advantage of ease in organizing the data. However, data from a remote sensor that will be fused will also need to be organized. Data from remote sensors that does not relate to the areas being monitored needs to be ignored.

The above information was found in various books and papers listed in References following this section. The "Artificial Neural Network Analysis System" proposed is to be written using the Neural Network Toolbox and Fuzzy Logic Toolbox by MathWorks Inc and the simulation of radar and infrared input to the system will use Matlab products.

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